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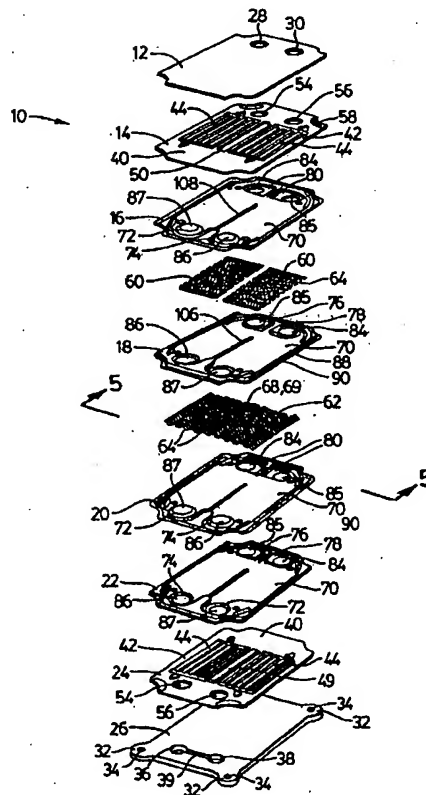
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Self-enclosing heat exchangers are made from stacked plates (16, 18, 20, 22) having raised peripheral flanges (90) on one side of the plates and continuous peripheral ridges (88) on the other side of the plates, so that when the plates are put together, fully enclosed alternating flow channels are provided between the plates. The plates have raised bosses (72, 74, 76, 78) defining fluid ports (87, 86, 85, 84) that line-up in the stacked plates to form manifolds for the flow of heat exchange fluids through alternate plates. Expanded metal turbulizers (60, 62, 63) are located in the flow channels. The turbulizers have portions (68, 69, 71, 73) thereof crimped closed to control the flow inside the channels and prevent unwanted bypass flow.



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TITLE OF THE INVENTION**SELF-ENCLOSING HEAT EXCHANGER  
WITH CRIMPED TURBULIZER**5 BACKGROUND OF THE INVENTION

This invention relates to heat exchangers of the type formed of stacked plates, wherein the plates have raised peripheral flanges that co-operate to form an enclosure for the passage of heat exchange fluids between the plates.

The most common kind of plate type heat exchangers produced in the past  
10 have been made of spaced-apart stacked pairs of plates where the plate pairs define internal flow passages therein. Expanded metal turbulizers are often located in the internal flow passages to increase turbulence and heat transfer efficiency. The plates normally have inlet and outlet openings that are aligned in the stacked plate pairs to allow for the flow of one heat exchange fluid through  
15 all of the plate pairs. A second heat exchange fluid passes between the plate pairs, and often an enclosure or casing is used to contain the plate pairs and cause the second heat exchange fluid to pass between the plate pairs.

In order to eliminate the enclosure or casing, it has been proposed to provide the plates with peripheral flanges that not only close the peripheral edges  
20 of the plate pairs, but also close the peripheral spaces between the plate pairs. One method of doing this is to use plates that have a raised peripheral flange on one side of the plate and a raised peripheral ridge on the other side of the plate. Examples of this type of heat exchanger are shown in U.S. patent No. 3,240,268 issued to F.D. Armes and U.S. patent No. 4,327,802 issued to Richard P.  
25 Beldam.

A difficulty with the self-enclosing plate-type heat exchangers produced in the past, however, is that the peripheral flanges and ridges form inherent peripheral flow channels that act as short-circuits inside and between the plate

pairs, and this reduces the heat exchange efficiency of these types of heat exchangers.

### DISCLOSURE OF THE INVENTION

5           In the present invention, portions of the expanded metal turbulizers are crimped closed to act as barriers to reduce short-circuit flow and to improve the flow distribution between the plates and the overall heat exchange efficiency of the heat exchangers.

          According to the invention, there is provided a plate type heat exchanger  
10 comprising first and second plates, each plate including a planar central portion, a first pair of spaced-apart bosses extending from one side of the planar central portion, and a second pair of spaced-apart bosses extending from the opposite side of the planar central portion. The bosses each have an inner peripheral edge portion and an outer peripheral edge portion defining a fluid port. A continuous  
15 ridge encircles the inner peripheral edge portions of at least the first pair of bosses and extends from the planar central portion in the same direction and equidistantly with the outer peripheral edge portions of the second pair of bosses. Each plate includes a raised peripheral flange extending from the planar central portion in the same direction and equidistantly with the outer peripheral  
20 edge portions of the first pair of bosses. The first and second plates are juxtaposed so that one of: the continuous ridges are engaged and the plate peripheral flanges are engaged; thereby defining a first flow chamber between the engaged ridges or peripheral flanges, with the fluid ports in one of said pairs of spaced-apart bosses forming an inlet and outlet to the first flow chamber, and  
25 the chamber defining a flow path between the inlet and outlet. The fluid ports in the respective first and second pairs of spaced-apart bosses are in registration. Also, an expanded metal turbulizer is located between the first and second plate planar central portions. The turbulizer includes a crimped portion located in the flow path to reduce short-circuit flow between the inlet and the outlet.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Preferred embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an exploded perspective view of a first preferred embodiment  
5 of a self-enclosing heat exchanger made in accordance with the present invention;

Figure 2 is an enlarged elevational view of the assembled heat exchanger of Figure 1;

Figure 3 is a plan view of the top two plates shown in Figure 1, the top  
10 plate being broken away to show the plate beneath it;

Figure 4 is a vertical sectional view taken along lines 4-4 of Figure 3, but showing both plates of Figure 3;

Figure 5 is an enlarged perspective view taken along lines 5-5 of Figure 1 showing one of the turbulizers used in the embodiment shown in Figure 1;

15 Figure 6 is an enlarged scrap view of the portion of Figure 5 indicated by circle 6 in Figure 5;

Figure 7 is a plan view of the turbulizer shown in Figure 5;

Figure 8 is a perspective view similar to Figure 5, but showing another embodiment of a turbulizer for use in the present invention;

20 Figure 9 is a perspective view of the turbulizer of Figure 8 but rotated 180 degrees about the longitudinal axis of the turbulizer;

Figure 10 is a plan view of the turbulizer as shown in Figure 8;

Figure 11 is a plan view of one side of one of the core plates used in the heat exchanger of Figure 1;

25 Figure 12 is a plan view of the opposite side of the core plate shown in Figure 11;

Figure 13 is a vertical sectional view taken along lines 13-13 of Figure 12;

Figure 14 is a vertical sectional view taken along lines 14-14 of Figure 12;

Figure 15 is a perspective view of the unfolded plates of a plate pair used to make yet another preferred embodiment of a heat exchanger according to the present invention;

Figure 16 is a perspective view similar to Figure 15, but showing the unfolded plates where they would be folded together face-to-face;

Figure 17 is a plan view of yet another preferred embodiment of a plate used to make a self-enclosing heat exchanger according to the present invention;

Figure 18 is a plan view of the opposite side of the plate shown in Figure 17;

Figure 19 is a vertical sectional view in along lines 19-19 of Figure 17, but showing the assembled plates of Figures 17 and 18; and

Figure 20 is a vertical elevational view of the assembled plates of Figures 17 to 19.

### BEST MODE FOR CARRYING OUT THE INVENTION

Referring firstly to Figures 1 and 2, an exploded perspective view of a preferred embodiment of a heat exchanger according to the present invention is generally indicated by reference numeral 10. Heat exchanger 10 includes a top or end plate 12, a turbulizer plate 14, core plates 16, 18, 20 and 22, another turbulizer plate 24 and a bottom or end plate 26. Plates 12 through 26 are shown arranged vertically in Figure 1, but this is only for the purposes of illustration. Heat exchanger 10 can have any orientation desired.

Top end plate 12 is simply a flat plate formed of aluminum having a thickness of about 1 mm. Plate 12 has openings 28, 30 adjacent to one end thereof to form an inlet and an outlet for a first heat exchange fluid passing through heat exchanger 10. The bottom end plate 26 is also a flat aluminum plate, but plate 26 is thicker than plate 12 because it also acts as a mounting plate

for heat exchanger 10. Extended corners 32 are provided in plate 26 and have openings 34 therein to accommodate suitable fasteners (are shown) for the mounting of heat exchanger 10 in a desired location. End plate 26 has a thickness typically of about 4 to 6 mm. End plate 26 also has openings 36, 38 to  
5 form respective inlet and outlet openings for a second heat exchange fluid for heat exchanger 10. Suitable inlet and outlet fittings or nipples (not shown) are attached to the plate inlets and outlets 36 and 38 (and also openings 28 and 30 in end plate 12) for the supply and return of the heat exchange fluids to heat exchanger 10.

10 Although it is normally not desirable to have short-circuit or bypass flow inside the heat exchanger core plates, in some applications, it is desirable to have some bypass flow in the flow circuit that includes heat exchanger 10. This bypass, for example, could be needed to reduce the pressure drop in heat exchanger 10, or to provide some cold flow bypass between the supply and  
15 return lines to heat exchanger 10. For this purpose, an optional controlled bypass groove 39 may be provided between openings 36, 38 to provide some deliberate bypass flow between the respective inlet and outlet formed by openings 36, 38.

Referring next to Figures 1, 3 and 4, turbulizer plates 14 and 24 will be described in further detail. Turbulizer plate 14 is identical to turbulizer plate 24,  
20 but in Figure 1, turbulizer plate 24 has been turned end-for-end or 180° with respect to turbulizer plate 14, and turbulizer plate 24 has been turned upside down with respect to turbulizer plate 14. The following description of turbulizer plate 14, therefore, also applies to turbulizer plate 24. Turbulizer plate 14 may be referred to as a shim plate, and it has a central planar portion 40 and a peripheral  
25 edge portion 42. Undulating passageways 44 are formed in central planar portion 40 and are located on one side only of central planar portion 40, as seen best in Figure 4. This provides turbulizer plate 14 with a flat top surface 45 to engage the underside of end plate 12. Openings 46, 48 are located at the respective ends of undulating passages 44 to allow fluid to flow longitudinally through the

undulating passageways 44 between top or end plate 12 and turbulizer 14. A central longitudinal rib 49, which appears as a groove 50 in Figure 3, is provided to engage the core plate 16 below it as seen in Figure 1. Turbulizer plate 14 is also provided with dimples 52, which also extend downwardly to engage core plate 16 below turbulizer 14. Openings 54 and 56 are also provided in turbulizer plate 14 to register with openings 28,30 in end plate 12 to allow fluid to flow transversely through turbulizer plate 14. Corner arcuate dimples 58 are also provided in turbulizer plate 14 to help locate turbulizer plate 14 in the assembly of heat exchanger 10. If desired, arcuate dimples 58 could be provided at all four corners of turbulizer plate 14, but only two are shown in Figures 1 to 3. These arcuate dimples also strengthen the corners of heat exchanger 10.

Referring next to Figures 1 and 5 to 7, heat exchanger 10 includes turbulizers 60 and 62 located between respective plates 16 and 18 and 18 and 20. Turbulizers 60 and 62 are formed of expanded metal, namely, aluminum, either by roll forming or a stamping operation. Staggered or offset transverse rows of convolutions 64 are provided in turbulizers 60, 62. The convolutions have flat tops 66 to provide good bonds with core plates 14, 16 and 18, although they could have round tops, or be in a sine wave configuration, if desired. Any type of turbulizer can be used in the present invention. As seen best in Figures 5 to 7, part of one of the transverse rows of convolutions 64 is compressed or roll formed or crimped together to form transverse crimped portions 68 and 69. For the purposes of this disclosure, the term crimped is intended to include crimping, stamping or roll forming, or any other method of closing up the convolutions in the turbulizers. Crimped portions 68, 69 reduces short-circuit flow inside the core plates, as will be discussed further below. It will be noted that only turbulizers 62 have crimped portions 68,. Turbulizers 60 do not have such crimped portions.

As seen best in Figure 1, turbulizers 60 are orientated so that the transverse rows of convolutions 64 are arranged transversely to the longitudinal



direction of core plates 16 and 18. This is referred to as a high pressure drop arrangement. In contrast, in the case of turbulizer 62, the transverse rows of convolutions 64 are located in the same direction as the longitudinal direction of core plates 18 and 20. This is referred to as the low pressure drop direction for  
5 turbulizer 62, because there is less flow resistance for fluid to flow through the convolutions in the same direction as row 64, as there is for the flow to try to flow through the row 64, as is the case with turbulizers 60.

Referring next to Figures 8 to 10, a modified turbulizer 63 is shown where, in addition to crimped portions 68, 69, the distal ends or short edges 71,  
10 73 are also crimped to help reduce short-circuit flow around the ends of the turbulizers, as will be described further below.

Referring next to Figures 1 and 11 to 14, core plates 16, 18, 20 and 22 will now be described in detail. All of these core plates are identical, but in the assembly of heat exchanger 10, alternating core plates are turned upside down.  
15 Figure 11 is a plan view of core plates 16 and 20, and Figure 12 is a plan view of core plates 18 and 22. Actually, Figure 12 shows the back or underside of the plate of Figure 11. Where heat exchanger 10 is used to cool oil using coolant such as water, for example, Figure 11 would be referred to as the water side of the core plate and Figure 12 would be referred to as the oil side of the core plate.

20 Core plates 16 through 22 each have a planar central portion 70 and a first pair of spaced-apart bosses 72, 74 extending from one side of the planar central portion 70, namely the water side as seen in Figure 11. A second pair of spaced-apart bosses 76, 78 extends from the opposite side of planar central portion 70, namely the oil side as seen in Figure 12. The bosses 72 through 78 each have an  
25 inner peripheral edge portion 80, and an outer peripheral edge portion 82. The inner and outer peripheral edge portions 80, 82 define openings or fluid ports 84, 85, 86 and 87. A continuous peripheral ridge 88 (see Figure 12) encircles the inner peripheral edge portions 80 of at least the first pair of bosses 72, 74, but usually continuous ridge 88 encircles all four bosses 72, 74, 76 and 78 as shown

in Figure 12. Continuous ridge 88 extends from planar central portion 70 in the same direction and equidistantly with the outer peripheral edge portions 82 of the second pair of bosses 76, 78.

Each of the core plate 16 to 22 also includes a raised peripheral flange 90 which extends from planar central portion 70 in the same direction and equidistantly with the outer peripheral edge portions 82 of the first pair of bosses 72, 74.

As seen in Figure 1, core plates 16 and 18 are juxtaposed so that continuous ridges 88 are engaged to define a first fluid chamber between the respective plate planar central portions 70 bounded by the engaged continuous ridges 88. In other words, plates 16, 18 are positioned back-to-back with the oil sides of the respective plates facing each other for the flow of a first fluid, such as oil, between the plates. In this configuration, the outer peripheral edge portions 82 of the second pair of spaced-apart bosses 76,78 are engaged, with the respective fluid ports 85,84 and 84,85 in communication. Similarly, core plates 18 and 20 are juxtaposed so that their respective peripheral flanges 90 are engaged also to define a first fluid chamber between the planar central portions of the plates and their respective engaged peripheral flanges 90. In this configuration, the outer peripheral edge portions 82 of the first pair of spaced-apart bosses 72,74 are engaged, with the respective fluid ports 87,86 and 86,87 being in communication. For the purposes of this disclosure, when two core plates are put together to form a plate pair defining a first fluid chamber therebetween, and a third plate is placed in juxtaposition with this plate pair, then the third plate defines a second fluid chamber between the third plate and the adjacent plate pair. In either case, the fluid ports 84 and 85 or 86 and 87 become inlets and outlets for the flow of fluid in a U-shaped flow path inside the first and second fluid chambers.

Referring in particular to Figure 11, a T-shaped rib 92 is formed in the planar central portion 70. The height of rib 92 is equal to the height of peripheral

flange 90. The head 94 of the T is located adjacent to the peripheral edge of the plate running behind bosses 76 and 78, and the stem 96 of the T extends longitudinally or inwardly between the second pair of spaced-apart bosses 76, 78. This T-shaped rib 92 engages the mating rib 92 on the adjacent plate and  
5 forms a barrier to prevent short-circuit flow between the inner peripheral edges 80 of the respective bosses 76 and 78. It will be appreciated that the continuous peripheral ridge 88 as seen in Figure 12 also produces a continuous peripheral groove 98 as seen in Figure 11. The T-shaped rib 92 prevents fluid from flowing from fluid ports 84 and 85 directly into the continuous groove 98 causing a  
10 short-circuit. It will be appreciated that the T-shaped rib 92 as seen in Figure 11 also forms a complimentary T-shaped groove 100 as seen in Figure 12. The T-shaped groove 100 is located between and around the outer peripheral edge portions 82 of bosses 76, 78, and this promotes the flow of fluid between and around the backside of these bosses, thus improving the heat exchange  
15 performance of heat exchanger 10.

In Figure 12, the location of turbulizers 60 is indicated by chain dotted lines 102. In Figure 11, the chain dotted lines 104 represent turbulizer 62. Turbulizer 62 could be formed of two side-by-side turbulizer portions or segments, rather than the single turbulizer as indicated in Figures 1 and 5 to 7. In  
20 Figure 11, the turbulizer crimped portions 68 and 69 are indicated by the chain-dotted lines 105. These crimped portions 68 and 69 are located adjacent to the stem 96 of T-shaped rib 92 and also the inner edge portions 80 of bosses 76 and 78, to reduce short-circuit flow between bosses 76 and 78 around rib 96.

Instead of using turbulizers 62 as indicated in Figures 1 and 11, the  
25 turbulizers 63 of Figure 8 to 10 could be used in heat exchanger 10. In this case, the crimped end portions 71, 73 would be a barrier and would block fluid flow from the turbulizer area to peripheral groove 98, again to reduce the bypass flow around peripheral groove 98. The crimped portions 68, 69 of turbulizer 62 and the crimped portions 71, 73 of turbulizer 63 are located in the flow paths inside

the fluid chambers inside the plate pairs to prevent or reduce short-circuit flow from the inlets and outlets defined by fluid ports 84, 85 and 86, 87. It will be appreciated that the locations in the turbulizers of the crimped portions 68, 69 and 71, 73 can be varied to suit any particular heat exchanger configuration or to  
5 control the flow path inside the plate pairs.

Core plates 16 to 22 also have another barrier located between the first pair of spaced-apart bosses 72 and 74. This barrier is formed by a rib 106 as seen in Figure 12 and a complimentary groove 108 as seen in Figure 11. Rib 106 prevents short-circuit flow between fluid ports 86 and 87 and again, the  
10 complimentary groove 108 on the water side of the core plates promotes flow between, around and behind the raised bosses 72 and 74 as seen in Figure 11. It will be appreciated that the height of rib 106 is equal to the height of continuous ridge 88 and also the outer peripheral edge portions 82 of bosses 76 and 78. Similarly the height of the T-shaped rib or barrier 92 is equal to the height of  
15 peripheral flange 90 and the outer peripheral edge portions 82 of bosses 72 and 74. Accordingly, when the respective plates are placed in juxtaposition, U-shaped flow passages or chambers are formed between the plates. On the water side of the core plates (Figure 11), this U-shaped flow passage is bounded by T-shaped rib 92, crimped portions 68 and 69 of turbulizer 62, and peripheral flange  
20 90. On the oil side of the core plates (Figure 12), this U-shaped flow passage is bounded by rib 106 and continuous peripheral ridge 88.

Referring once again to Figure 1, heat exchanger 10 is assembled by placing turbulizer plate 24 on top of end plate 26. The flat side of turbulizer plate 24 goes against end plate 26, and thus undulating passageways 44 extend above  
25 central planar portion 40 allowing fluid to flow on both sides of plate 24 through undulating passageways 44 only. Core plate 22 is placed overtop turbulizer plate 24. As seen in Figure 1, the water side (Figure 11) of core plate 22 faces downwardly, so that bosses 72, 74 project downwardly as well, into engagement with the peripheral edges of openings 54 and 56. As a result, fluid flowing

through openings 36 and 38 of end plate 26 pass through turbulizer openings 54, 56 and bosses 72, 74 to the upper or oil side of core plate 22. Fluid flowing through fluid ports 84 and 85 of core plate 22 would flow downwardly and through the undulating passageways 44 of turbulizer plate 24. This flow would  
5 be in a U-shaped direction, because rib 48 in turbulizer plate 24 covers or blocks longitudinal groove 108 in core plate 22, and also because the outer peripheral edge portions of bosses 72, 74 are sealed against the peripheral edges of turbulizer openings 54 and 56, so the flow has to go around or past bosses 72,74. Further core plates are stacked on top of core plate 22, first back-to-back as is  
10 the case with core plate 20 and then face-to-face as is the case with core plate 18 and so on. Only four core plates are shown in Figure 1, but of course, any number of core plates could be used in heat exchanger 10, as desired.

At the top of heat exchanger 10, the flat side of turbulizer plate 14 bears against the underside of end plate 12. The water side of core plate 16 bears  
15 against turbulizer plate 14. The peripheral edge portion 42 of turbulizer plate 14 is coterminous with peripheral flange 90 of core plate 14 and the peripheral edges of end plate 12, so fluid flowing through openings 28,30 has to pass transversely through openings 54,56 of turbulizer plate 14 to the water side of core plate 16. Rib 48 of turbulizer plate 14 covers or blocks groove 108 in core  
20 plate 14. From this, it will be apparent that fluid, such as water, entering opening 28 of end plate 12 would travel between turbulizer plate 14 and core plate 16 in a U-shaped fashion through the undulating passageways 44 of turbulizer plate 14, to pass up through opening 30 in end plate 12. Fluid flowing into opening 28 also passes downwardly through fluid ports 84 and 85 of  
25 respective core plates 16,18 to the U-shaped fluid chamber between core plates 18 and 20. The fluid then flows upwardly through fluid ports 84 and 85 of respective core plates 18 and 16, because the respective bosses defining ports 84 and 85 are engaged back-to-back. This upward flow then joins the fluid flowing through opening 56 to emerge from opening 30 in end plate 12. From this it will

be seen that one fluid, such as coolant or water, passing through the openings 28 or 30 in end plate 12 travels through every other water side U-shaped flow passage or chamber between the stacked plates. The other fluid, such as oil, passing through openings 36 and 38 of end plate 26 flows through every other oil side U-shaped passage in the stacked plates that does not have the first fluid passing through it.

Figure 1 also illustrates that in addition to having the turbulizers 60 and 62 orientated differently, the turbulizers can be eliminated altogether, as indicated between core plates 20 and 22. Turbulizer plates 14 and 24 are actually shim plates. Turbulizer plates 14, 24 could be replaced with turbulizers 60 or 62, but the height or thickness of such turbulizers would have to be half that of turbulizers 60 and 62 because the spacing between the central planar portions 70 and the adjacent end plates 12 or 26 is half as high the spacing between central planar portions 70 of the juxtaposed core plates 16 to 22.

Referring again to Figures 11 and 12, planar central portions 70 are also formed with further barriers 110 having ribs 112 on the water side of planar central portions 70 and complimentary grooves 114 on the other or oil side of central planar portions 70. The ribs 112 help to reduce bypass flow by helping to prevent fluid from passing into the continuous peripheral grooves 98, and the grooves 114 promote flow on the oil side of the plates by encouraging the fluid to flow into the corners of the plates. Ribs 112 also perform a strengthening function by being joined to mating ribs on the adjacent or juxtaposed plate. Dimples 116 are also provided in planar central portions 70 to engage mating dimples on juxtaposed plates for strengthening purposes.

Referring next to Figures 15 and 16, some further plates are shown for producing yet another preferred embodiment of a self-enclosing heat exchanger according to the present invention. In this embodiment, the plates 150, 152, 154 and 156 are circular and they are identical in plan view. Figure 15 shows the oil side of a pair of plates 150, 152 that have been unfolded along a chain-dotted

fold line 158. Figure 16 shows the water side of a pair of plates 154, 156 that have been unfolded along a chain-dotted fold line 160. Again, core plates 150 to 156 are quite similar to the core plates shown in Figures 1 to 14, so the same reference numerals are used in Figures 15 and 16 to indicate components or portions of the plates that are functionally the same as the embodiment of Figures 1 to 14.

In the embodiment of Figures 15 and 16, the bosses of the first pair of spaced-apart bosses 72, 74 are diametrically opposed and located adjacent to the continuous peripheral ridge 88. The bosses of the second pair of spaced-apart bosses 76, 78 are respectively located adjacent to the bosses 74, 72 of the first pair of spaced-apart bosses. Bosses 72 and 78 form a pair of associated input and output bosses, and the bosses 74 and 76 form a pair of associated input and output bosses. Oil side barriers in the form of ribs 158 and 160 reduce the likelihood of short circuit oil flow between fluid ports 86 and 87. As seen best in Figure 15, ribs 158, 160 run tangentially from respective bosses 76, 78 into continuous ridge 88, and the heights of bosses 76, 78, ribs 158, 160 and continuous ridge 88 are all the same. The ribs or barriers 158, 160 are located between the respective pairs of associated input and output bosses 74, 76 and 72, 78. Actually, barriers or ribs 158, 160 can be considered to be spaced-apart barrier segments located adjacent to the respective associated input and output bosses. Also, the barrier ribs 158, 160 extend from the plate central planar portions in the same direction and equidistantly with the continuous ridge 88 and the outer peripheral edge portions 82 of the second pair of spaced-apart bosses 76, 78.

A plurality of spaced-apart dimples 162 and 164 are formed in the plate planar central portions 70 and extend equidistantly with continuous ridge 88 on the oil side of the plates and raised peripheral flange 90 on the water side of the plates. The dimples 162, 164 are located to be in registration in juxtaposed first and second plates, and are thus joined together to strengthen the plate pairs, but

dimples 162 also function to create flow augmentation between the plates on the oil side (Figure 15) of the plate pairs. It will be noted that most of the dimples 162, 164 are located between the barrier segments or ribs 158, 160 and the continuous ridge 88. This permits a turbulizer, such as turbulizer 60 of the Figure 1 embodiment, to be inserted between the plates as indicated by the chain-dotted line 166 in Figure 15. Also, a turbulizer with crimped portions, like the crimped end portions 71, 73 of turbulizers 63 could be used to help reduce bypass flow around the periphery of the plates.

On the water side of plates 154, 156 as seen in Figure 16, a barrier rib 168 is located in the centre of the plates and is of the same height as the first pair of spaced-apart bosses 72, 74. Barrier rib 168 reduces short circuit flow between fluid ports 84 and 85. The ribs 168 are also joined together in the mating plates to perform a strengthening function. Alternatively, a turbulizer like turbulizer 62 of Figure 1 could be used where the central crimped portions 68, 69 would take the place of barrier rib 168, the latter would then not be formed in plates 150, 152.

Barrier ribs 158, 160 have complimentary grooves 170, 172 on the opposite or water sides of the plates, and these grooves 170, 172 promote flow to and from the peripheral edges of the plates to improve the flow distribution on the water side of the plates. Similarly, central rib 168 has a complimentary groove 174 on the oil side of the plates to encourage fluid to flow toward the periphery of the plates.

Referring next to Figures 17 to 20, yet another embodiment of a self-enclosing heat exchanger will now be described. In this embodiment, a plurality of elongate flow directing ribs are formed in the plate planar central portions to prevent short-circuit flow between the respective ports in the pairs of spaced-apart bosses. In Figures 17 to 20, the same reference numerals are used to indicate parts and components that are functionally equivalent to the embodiments described above.



Figure 17 shows a core plate 212 that is similar to core plates 16, 20 of Figure 1, and Figure 18 shows a core plate 214 that is similar to core plates 18, 22 of Figure 1. In core plate 212, the barrier rib between the second pair of spaced-apart bosses 76, 78 is more like a U-shaped rib 216 that encircles bosses 76, 78, but it does have a central portion or branch 218 that extends between the second pair of spaced-apart bosses 76, 78. The U-shaped portion of rib 216 has distal branches 220 and 222 that have respective spaced-apart rib segments 224, 226 and 228, 230 and 232. The distal branches 220 and 222, including their respective rib segments 224, 226 and 228, 230 and 232 extend along and adjacent to the continuous peripheral groove 98. Central branch or portion 218 includes a bifurcated extension formed of spaced-apart segments 234, 236, 238 and 240. It will be noted that all of the rib segments 224 through 240 are asymmetrically positioned or staggered in the plates, so that in juxtaposed plates having the respective raised peripheral flanges 90 engaged, the rib segments form half-height overlapping ribs to reduce bypass or short-circuit flow into the continuous peripheral groove 98 or the central longitudinal groove 108. It will also be noted that there is a space 241 between rib segment 234 and branch 218. This space 241 allows some flow therethrough to prevent stagnation which otherwise may occur at this location. As in the case of the previously embodied, the U-shaped rib 216 forms a complimentary groove 242 on the oil side of the plates as seen in Figure 18. This groove 242 promotes the flow of fluid between, around and behind bosses 76, 78 to improve the efficiency of the heat exchanger formed by plates 212, 214.

The oil side of the plates can also be provided with turbulizers as indicated by chain-dotted lines 244, 246 in Figure 18. These turbulizers preferably will be the same as turbulizers 60 in the embodiment of Figure 1. However, turbulizers like turbulizer 63 could also be used, in which case the crimped portions would run in the longitudinal direction of plates 212, 214. The crimped end portions 71, 73 of such turbulizers 63 could be crimped

intermittently to produce the same result as rib segments 224 to 232, as could the central crimped portions 68, 69 to give the same effect as rib segments 234 to 240. Of course, where crimped turbulizers are used, the various rib segments would not be used.

- 5        It is also possible to make the bifurcated extension of central branch 218 so that the forks consisting of respective rib segments 234, 236 and 238, 240 diverge. This would be a way to adjust the flow distribution or flow velocities across the plates and achieve uniform velocity distribution inside the plates.

      In the above description, for the purposes of clarification, the terms oil  
10 side and water side have been used to describe the respective sides of the various core plates. It will be understood that the heat exchangers of the present invention are not limited to the use of fluids such as oil or water. Any fluids can be used in the heat exchangers of the present invention. Also, the configuration or direction of flow inside the plate pairs can be chosen in any way desired  
15 simply by choosing which of the fluid flow ports 84 to 87 will be inlet or input ports and which will be outlet or output ports.

      Having described preferred embodiments of the invention, it will be appreciated that various modifications may be made to the structures described above. For example, the heat exchangers can be made in any shape desired.  
20 Although the heat exchangers have been described from the point of view of handling two heat transfer fluids, it will be appreciated that more than two fluids can be accommodated simply by nesting or expanding around the described structures using principles similar to those described above. Further, some of the features of the individual embodiments described above can be mixed and  
25 matched and used in the other embodiments as will be appreciated by those skilled in the art.

      As will be apparent to those skilled in the art in the light of the foregoing disclosure, many alterations and modifications are possible in the practice of this invention without departing from the spirit or scope thereof. Accordingly, the

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scope of the invention is to be construed in accordance with the substance defined by the following claims.

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**WHAT IS CLAIMED IS:****1. A plate type heat exchanger comprising:**

first and second plates, each plate including a planar central portion, a first pair of spaced-apart bosses extending from one side of the planar central portion, and a second pair of spaced-apart bosses extending from the opposite side of the planar central portion, said bosses each having an inner peripheral edge portion, and an outer peripheral edge portion defining a fluid port; a continuous ridge encircling the inner peripheral edge portions of at least the first pair of bosses and extending from the planar central portion in the same direction and equidistantly with the outer peripheral edge portions of the second pair of bosses;

each plate including a raised peripheral flange extending from the planar central portion in the same direction and equidistantly with the outer peripheral edge portions of the first pair of bosses;

the first and second plates being juxtaposed so that one of: the continuous ridges are engaged or the plate peripheral flanges are engaged; thereby defining a first fluid chamber between the engaged ridges or peripheral flanges, with the fluid ports in one of said pairs of spaced-apart bosses forming an inlet and an outlet to said first flow chamber, and said chamber defining a flow path between said inlet and outlet; the fluid ports in the respective first and second pairs of spaced-apart bosses being in registration; and

an expanded metal turbulizer located between the first and second plate planar central portions, the turbulizer including a crimped portion located in said flow path to reduce short-circuit flow between said inlet and outlet.

**2. A plate type heat exchanger as claimed in claim 1 wherein the continuous ridge encircles both the first and second pairs of spaced-apart bosses and further**

comprising a third plate located in juxtaposition with one of the first and second plates to define a second fluid chamber between the third plate and the central planar portion of the adjacent plate.

3. A plate type heat exchanger as claimed in claim 2 wherein the first and second plate peripheral flanges are engaged and wherein the turbulizer is located in the first fluid chamber defined thereby.

4. A plate type heat exchanger as claimed in claim 2 wherein the plates are circular in plan view, the bosses of the first pair of spaced-apart bosses are diametrically opposed and located adjacent to the continuous ridge, the bosses of the second pair of spaced-apart bosses are respectively located adjacent to the bosses of the first pair of spaced-apart bosses to form pairs of associated input and output bosses, and the turbulizer is located between the respective pairs of associated input and output bosses.

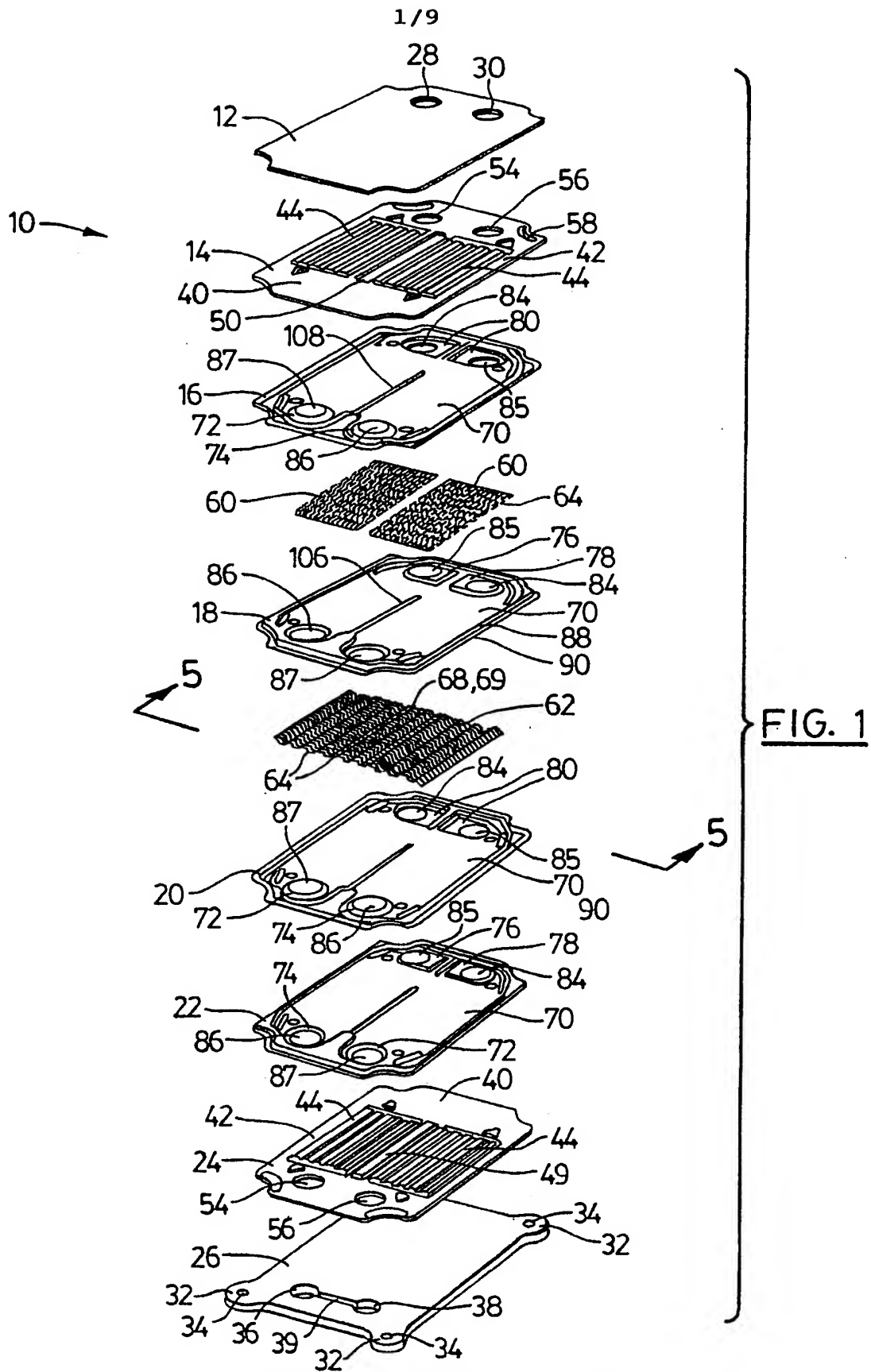
5. A plate type heat exchanger as claimed in claim 2 and further comprising a turbulizer located inside the second fluid chamber.

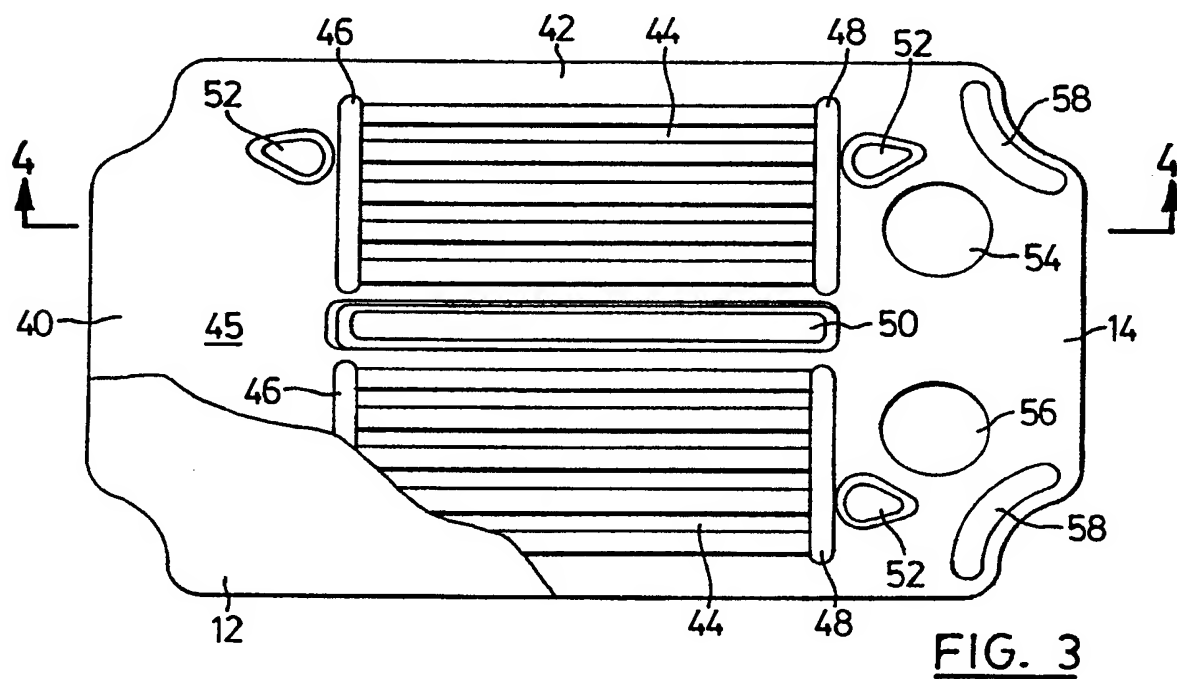
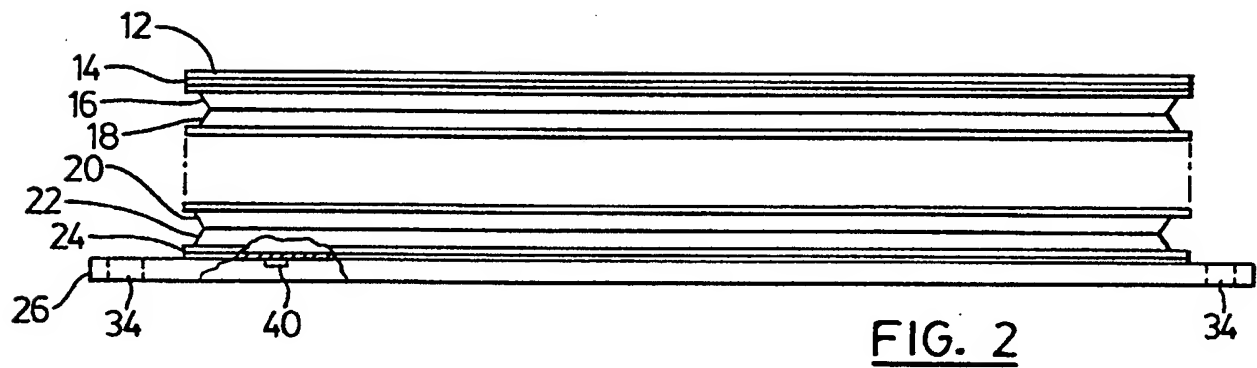
6. A plate type heat exchanger as claimed in claim 3 wherein the planar central portion includes a barrier formed of a rib and complimentary groove, the rib being located between the inner peripheral edge portions of the bosses of the first pair of spaced-apart bosses, the groove being located in the first fluid chamber, and the turbulizer crimped portion being located over the groove to reduce short-circuit flow through the groove.

7. A plate type heat exchanger as claimed in claim 1 wherein the continuous ridge encircles both the first and second pairs of spaced-apart bosses,

said continuous ridge forming a complimentary continuous peripheral groove around the plate adjacent to the raised peripheral flange, the turbulizer having crimped end portions located adjacent to the continuous peripheral groove to reduce short-circuit flow therethrough.

8. A plate type heat exchanger as claimed in claim 3 wherein the planar central portion includes a barrier formed of a rib and complimentary groove, the rib being located between the inner peripheral edge portions of the bosses of the first pair of spaced-apart bosses, the groove being located in the first fluid chamber, and the turbulizer crimped portion being located over the groove to reduce short-circuit flow through the groove.







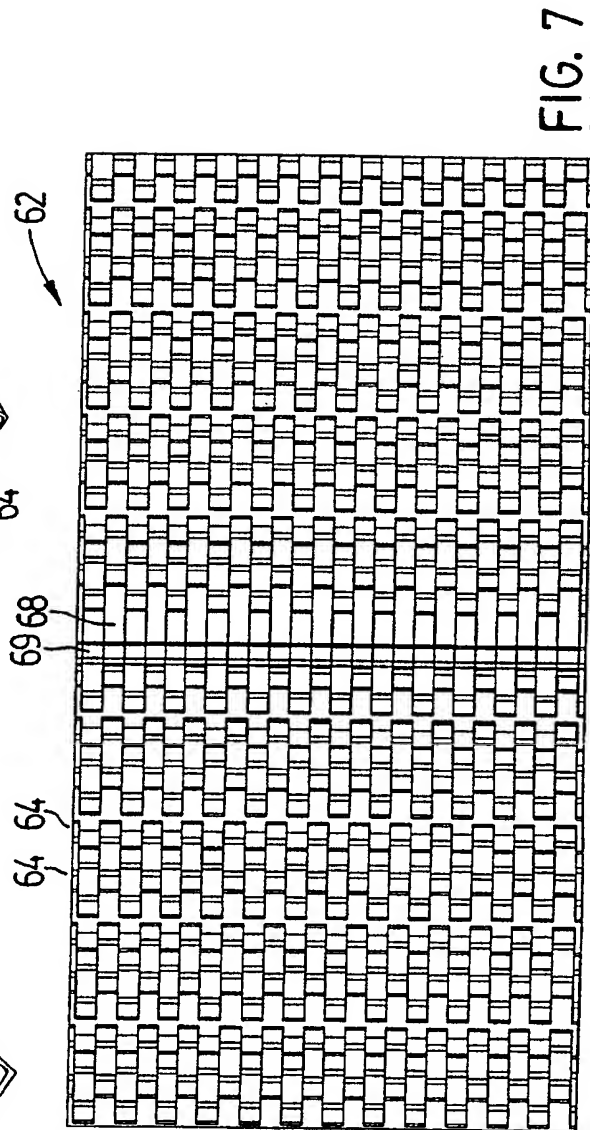
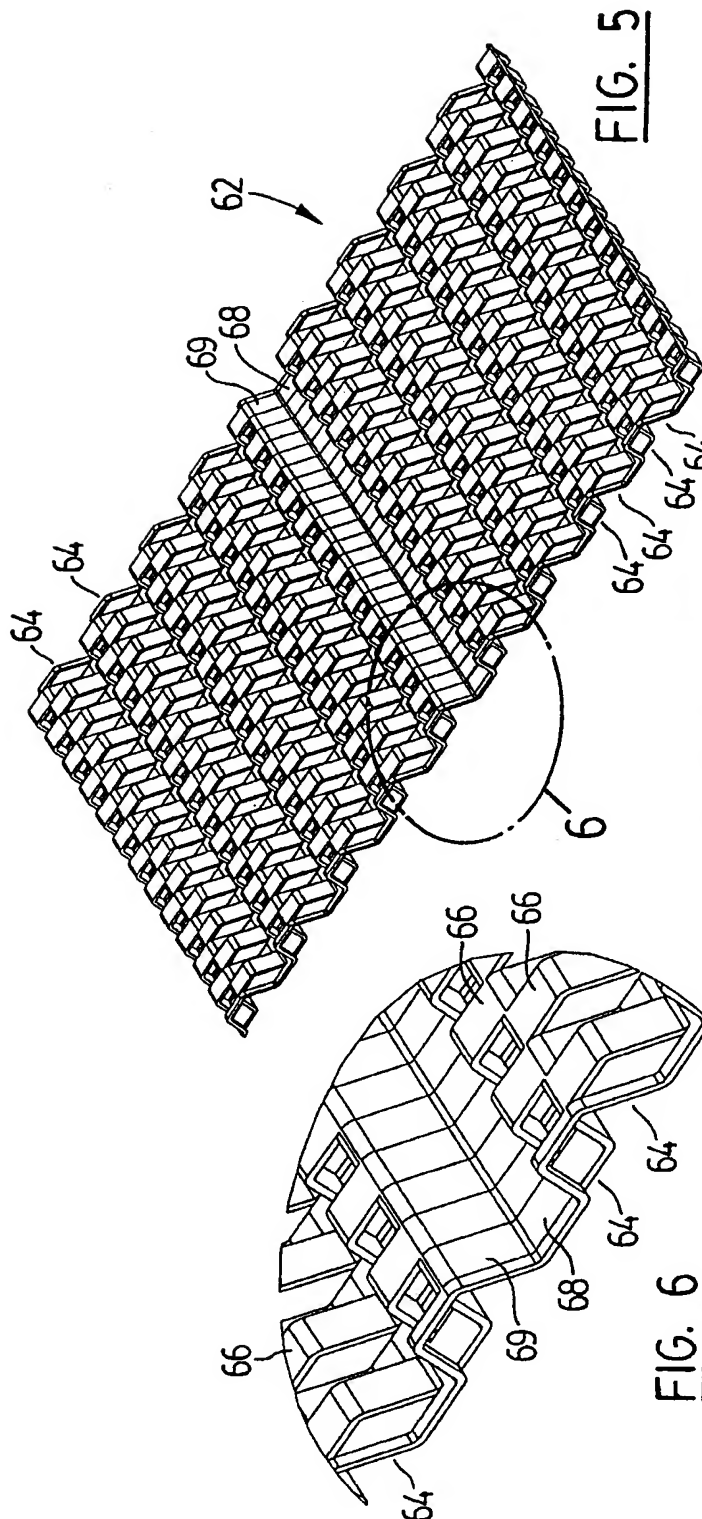


FIG. 7

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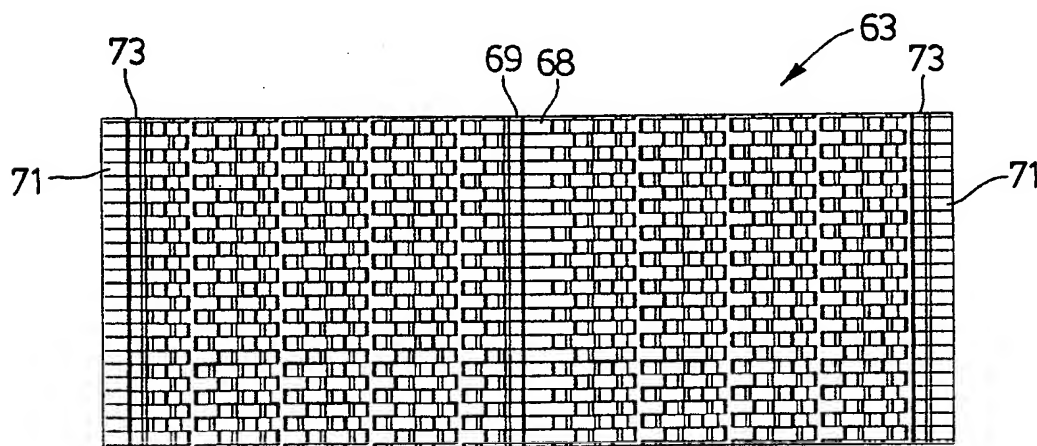
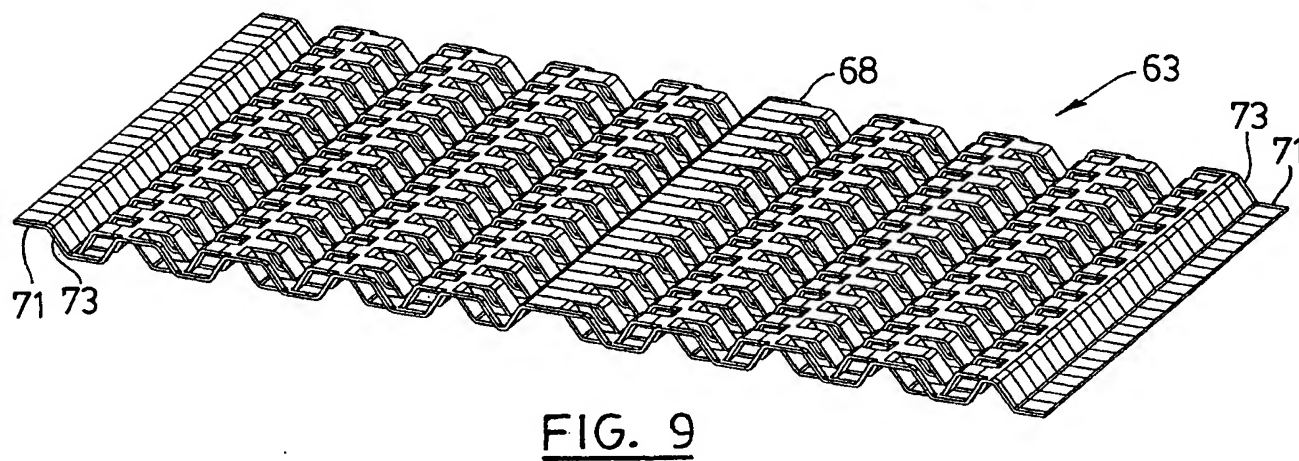
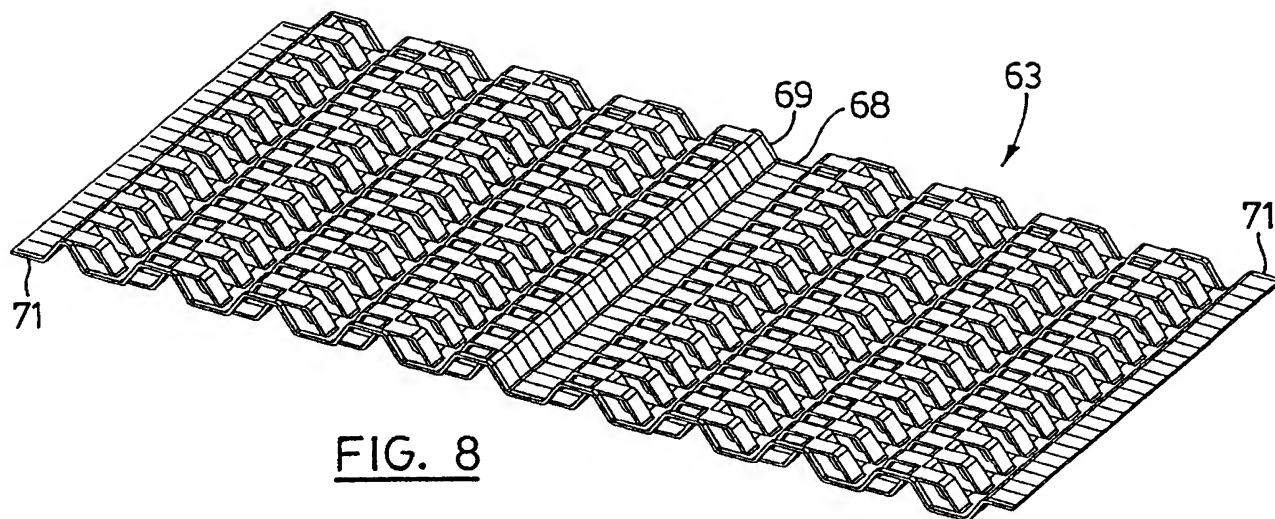


FIG. 10

SUBSTITUTE SHEET (RULE 26)

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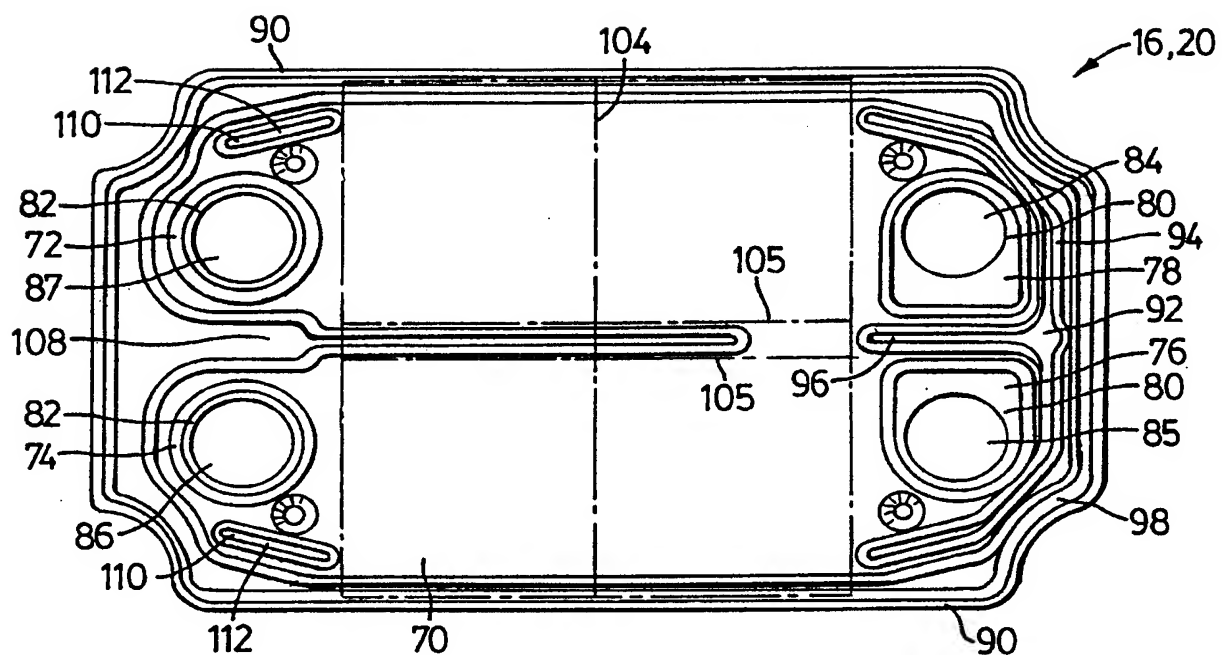


FIG. 11

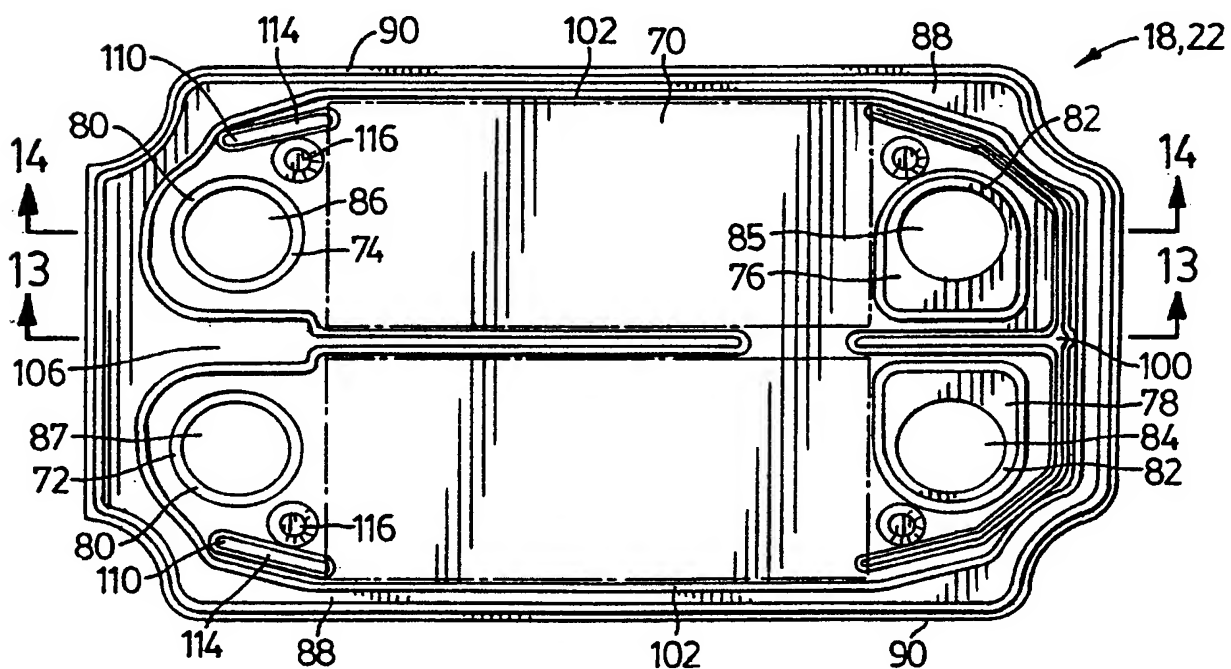


FIG. 12

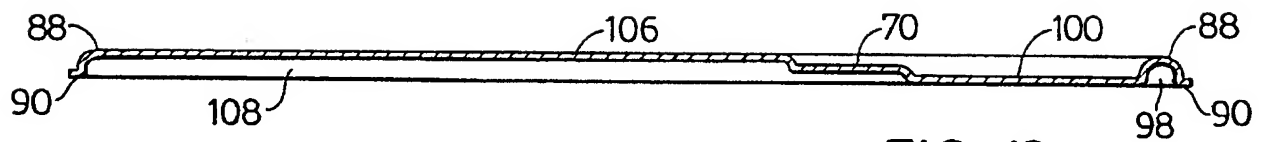


FIG. 13

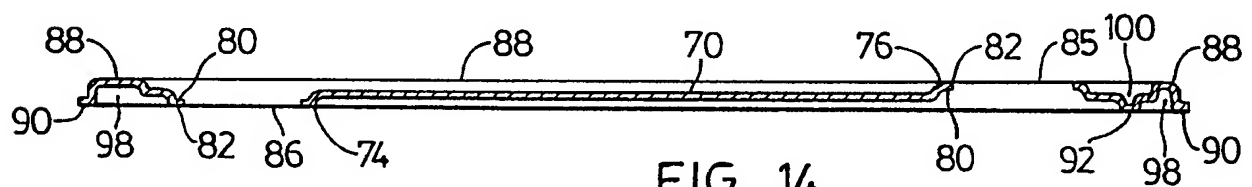


FIG. 14

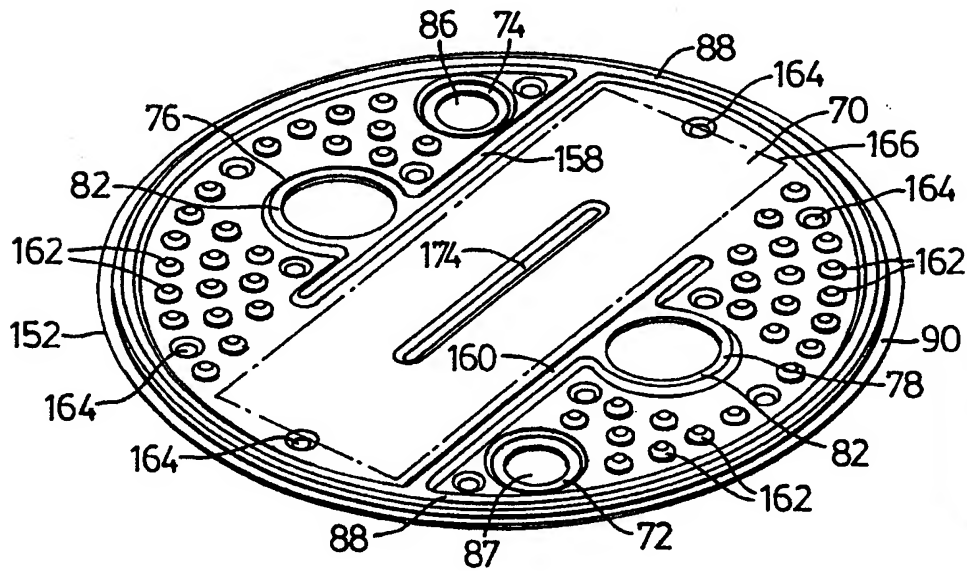
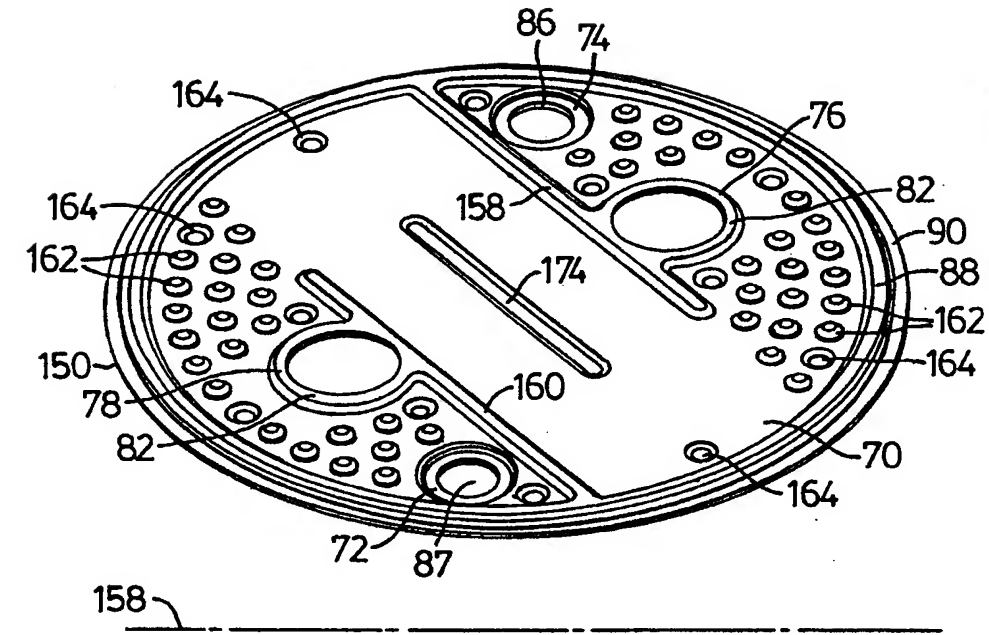
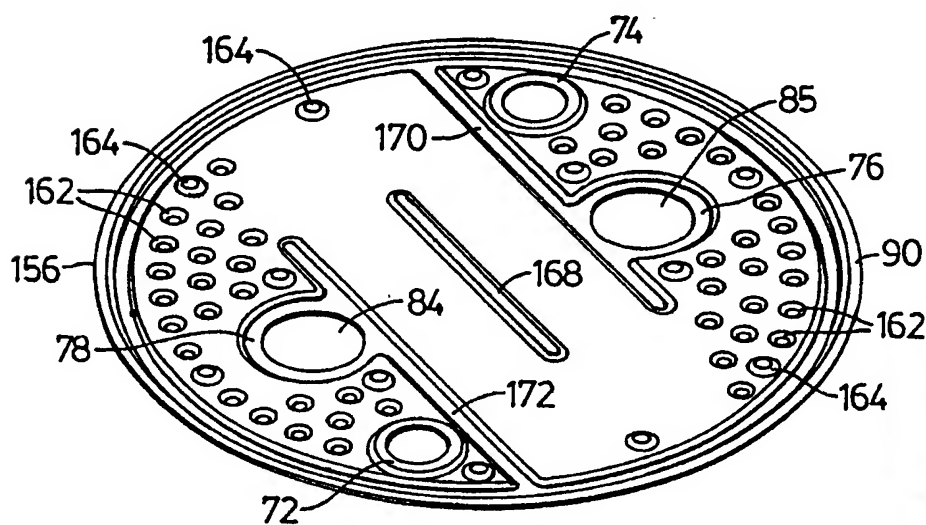
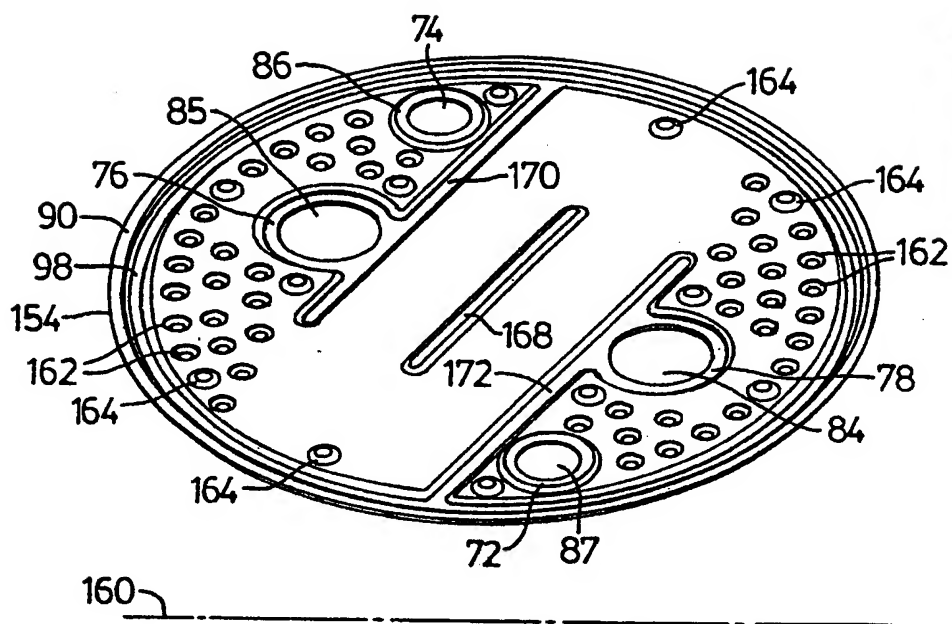
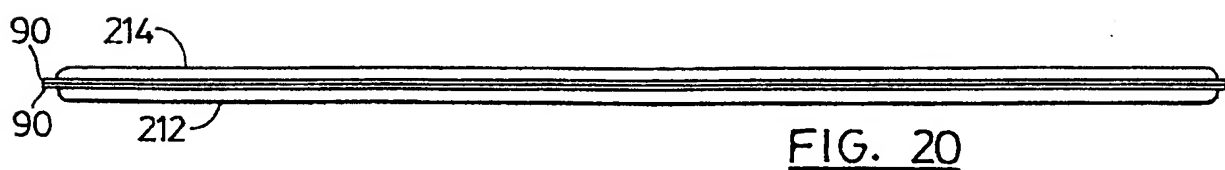
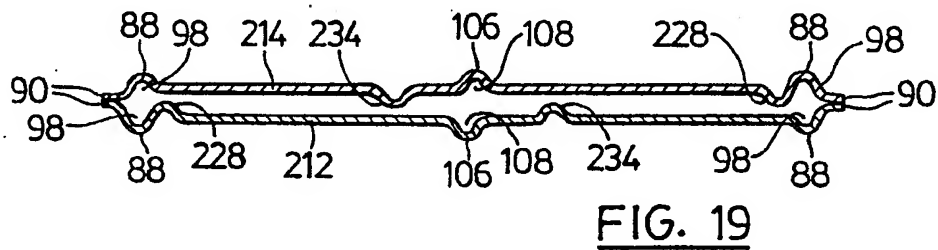
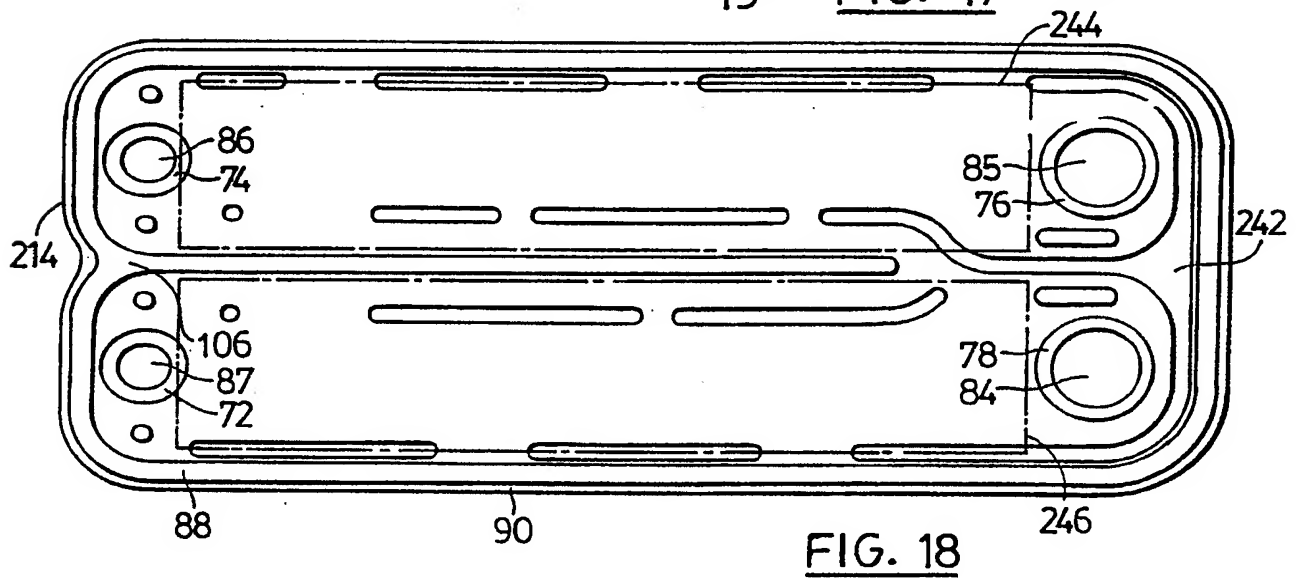
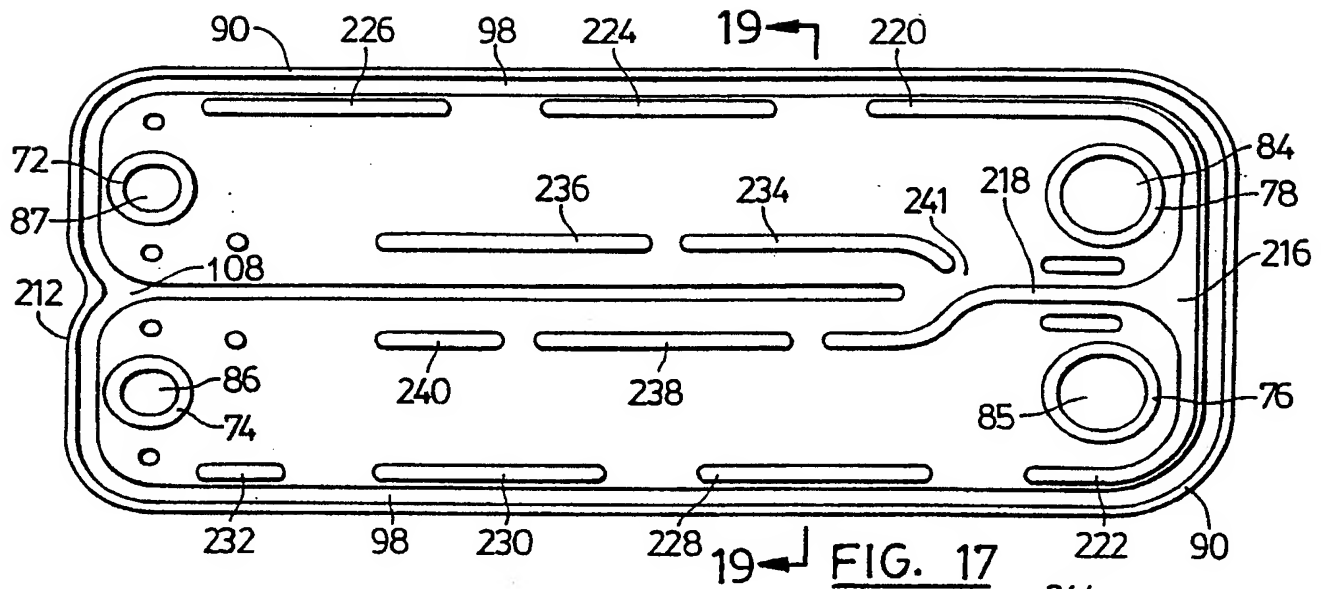


FIG. 15



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# INTERNATIONAL SEARCH REPORT

International Application No

PCT/CA 00/00112

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F28D9/00 F28F13/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F28D F28F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 296 22 191 U (KTM KUEHLER GMBH) 13 February 1997 (1997-02-13) page 5, paragraph 2; figures	1,3,5,7
A	EP 0 347 961 A (ITT) 27 December 1989 (1989-12-27) column 5, line 44 - line 50; figure 1	1,3,5,7
A	WO 93 15369 A (ALFA LAVAL THERMAL) 5 August 1993 (1993-08-05) abstract; figures	1,2
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

23 May 2000

Date of mailing of the international search report

31/05/2000

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# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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